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Subject: Dwarf Mistletoe Infection in the Jacob Ryan Analysis Area

To: District Ranger, North Kaibab RD, Attn: Environmental Coordinator

The following briefly describes existing conditions of southwestern dwarf mistletoe infection on ponderosa pine in the Jacob Ryan analysis area. Site-level vegetation information was provided by Tim Howard and is based on stand exams. Tim used stand exam information and walkthrough reconnaissance performed by himself and Dave Stephenson for prescribing treatments.

During stand exams, each inventory tree is assigned a dwarf mistletoe rating (DMR) using Hawksworth's[i] 6-class system. This rating system divides the live crown of trees into thirds, and each third is rated separately as: 0, no mistletoe infection; 1, less than 50% of live branches infected; 2, more than 50% of live branches infected. The ratings for each third are totaled to obtain the DMR for a tree. Mean DMR for a site (stand) is calculated by adding the DMRs for all live trees, infected and uninfected, greater than 1 inch diameter at breast height (DBH) in the stand and dividing by the total number of trees. Tim Howard provided this information broken down by VSS class for each stand within the analysis area.

Thirty-two percent of the stands in the analysis area are infected with dwarf mistletoe. More than half of the infected sites are lightly infected (stand DMR <0.5), and about 25% are heavily to severely infected (stand DMR >1.0). There are several stands with DMR levels greater than 3.5. Stands with higher levels of infection have fewer options for management, since the impact on growth and longevity is so severe at these levels. There are many stands in the analysis area with smaller size classes of infected, since the overstory mistletoe seed source was removed in past treatments. Dwarf mistletoe infection is higher along ridge tops, which is believed to be associated with the high light intensity of ridges, higher relative humidity (the result of ascending humid air currents), and slow growth rates due to poor soil quality.

Mistletoe infection levels should be considered when prescribing silvicultural treatments because of its impact on the development of stands. Some of these affects are beneficial, (e.g., mistletoe infection directly and indirectly provides forage and nesting habitat); however, mistletoe also causes mortality and growth loss so the level of impact across a landscape is important.

Dwarf Mistletoe Biology/Ecology

Dwarf mistletoes are parasitic, seed-bearing plants that depend on their hosts almost completely for water and nutrients. They are natural components of many forest ecosystems in the West, causing significant changes in physiological processes and structural characteristics of infected trees, which result in changes in the structure and function of forest communities.[ii iii] Infected host trees are slowly weakened and eventually killed as dwarf mistletoe drains them of water and nutrients. Overall effects on forest structure in a site that has been infected for many generations

include: increased stand openings; lower crown canopy; denser canopy due to witches' brooms; and fewer large diameter trees.

These impacts can provide forage for many species of birds[iv] and mammals[v]. Although many bird species have been observed feeding on mistletoe berries and shoots, there is little quantitative data on any except for blue grouse, which has been found to consume Douglas-fir dwarf mistletoe shoots in the fall. Insectivorous birds feed on insects that feed on the shoots, fruits and seeds of dwarf mistletoe, as well as on bark beetles that attack trees weakened by dwarf mistletoes. Recent research has measured positive, negative, and null correlations between mistletoe related variables (e.g., the amount of mistletoe on a site and snag density) and bird species abundance in ponderosa pine sites in Arizona. Of the 16 bird species investigated by Parker[vi], a positive relationship was found for 4 species, negative correlation for 5 species, and no correlation for 7 species. Three of the 4 species that were positively correlated with dwarf mistletoe infestation or snag density were cavity-nesting birds. The only foliage nesting bird with a positive relationship was western tanager. Bennetts[vii] found a positive correlation between mistletoe infection and 24 bird species; however, his Colorado study sites had a mixed-conifer and understory shrub component absent from Parker's study sites in Arizona.

Dwarf mistletoe infections can result in the formation of abnormal growth structures or branching patterns in the host known as witches' brooms. These structures are frequently used for foraging/caching, nesting, and roosting/resting sites by birds and mammals[viii]. Garnett[ix] found 23% of examined witches' brooms in studies near Flagstaff, AZ, contained evidence of wildlife use, with Abert squirrels being the most common users.

Survival of an infected host is influenced by the severity of dwarf mistletoe infection and site factors. Hawksworth and Geils[x] determined 32-year survival rates of tagged ponderosa pines with various intensities of dwarf mistletoe infection at Grand Canyon National Park, AZ. While more than 90% of the uninfected and lightly infected trees survived the 32-year period, only 5% of the heavily infected trees over 9 in. dbh and none of those in the 4-9 in. dbh class survived. Heavily infected trees are frequently attacked by secondary bark beetles, which hasten their death.

Dwarf mistletoes have a fairly complicated and long life cycle. Seeds of dwarf mistletoes are explosively released and expelled to distances typically ranging from 10 to 40 feet. Infection takes place through the bark on needle-bearing portions of twigs. Dwarf mistletoes first produce an endophytic system, a specialized rootlike structure that is in contact with the phloem and xylem of host trees, from which the parasite obtains most of its nutrients and water. Aerial shoots appear between 2 to 5 years after infection; fruit development occurs two to three years later. The period of infection before shoots are visible is known as the latent period.

Spread of dwarf mistletoe is a function of stand structure, density, age, and site index. Spread from overstory to understory is the most rapid, because it is multidimensional. Initially, all infections in the young stand develop directly from seeds produced from overstory trees. Then there is a transition period when infections in the young stand begin to produce seeds that further infect the stand. Subsequently, infection in the young stand progresses outward beyond the range of the seeds produced in the overstory stand. Spread through even-aged stands, beyond the limit of seed from an overstory source, is termed **lateral spread**.

Researchers[xi] [xii] measured the distance of infected seedlings from the source of overstory trees at different time intervals. In 20-year-old stands, nearly all infection was found to be attributable to seed produced in the overstory with 80 percent of infected seedlings within 35 feet of the infected overstory trees. In 50-year-old stands, lateral spread accounted for about one-half of the spread in open stands and one-third of the total in dense stands, with distances from the original overstory seed source reaching nearly 80 feet and 65 feet, respectively.

Wildfires are one of the primary ecological factors in determining the distribution and intensity of dwarf mistletoes in unmanaged coniferous forests. During wildfires, relatively complete burns tend to have a sanitizing effect on dwarf mistletoe infected stands if all susceptible trees are killed. However, partial burns can lead to rapid infection of regeneration, if scattered infected trees remain over newly established regeneration. Prescribed burns tend to reduce infection levels, since severely mistletoe infected trees, as well as limbs located in the lower crowns of trees, are killed back. Two studies that evaluated the interaction of fire and dwarf mistletoe on mortality of southwestern ponderosa pine following prescribed burning found heavily infected trees had reduced survival rates compared to lightly infected or non-infected trees[xiii] [xiv].

Silvicultural Control Options

The impacts of dwarf mistletoe infection used to be based on single variables relating to timber production, such as wood volume or basal area. Disease effects are now assessed on a wider range of resource values including wildlife and recreation. In lightly to moderately infected stands, even-aged stand conditions are often advised in timber producing blackjack (VSS3) areas in order to slow the spread of disease (i.e., mistletoe spreads more slowly on trees growing on good quality sites). Where wildlife is emphasized and growth impacts are not a major concern, more mistletoe can exist without a detrimental effect. The most important factor to keep in mind if regeneration is intended to become the future old growth is the impact of long term dwarf mistletoe infection from an overstory seed source. Although a heavily infected site may be the best wildlife habitat now, it is the ratio of these across the landscape that is important for being able to maintain quality habitat.

Silvicultural prescriptions are applied with regard for reducing the impact dwarf mistletoe infection has on achieving resource objectives. The greater the infection level, the fewer treatment options available. Lightly to moderately infected stands can be thinned, depending on the age and structure of the stand, without impacts to timber or wildlife resources. Multi-storied stands with heavily infected overstory trees are either regenerated or deferred, depending on the management objectives and frequency of this condition within an analysis area.

If you have any questions, please give me a call at (928) 556-2075.

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[i] Hawksworth, F.G. 1977. The 6-class dwarf mistletoe rating system. USDA Forest Service, General Technical Report RM-48. 7pp.

[ii] Parmeter, J.R., Jr. 1978. Forest stand dynamics and ecological factors in relation to dwarf mistletoe spread, impact, and control. P. 16-30, In: Proceedings of the symposium on dwarf mistletoe control through forest management. Robert F. Scharpf and John R. Parmeter, Jr., Tech. Coords., April 11-13, 1978, Berkeley, CA: USDA Forest Service General Technical Report PSW-31, 190 p.

[iii] Tinnin, R.O. 1984. The effect of dwarf mistletoe on forest community ecology. P. 117-122, In: Biology of Dwarf Mistletoes: Proceeding of the Symposium. Frank G. Hawksworth and Robert F. Scharpf, Tech. Coords., August 8, 1984, Ft. Collins, CO: USDA Forest Service General Technical Report RM-111, 131 p.

[iv] Hawksworth, F.G. and B.W. Geils. 1996. Biotic associates. In: Hawksworth, F.G. and D. Wiens. 1996. Dwarf mistletoes: biology, pathology, and systematics. Agric. Handb. 709. Washington, DC: U.S. Department of Agriculture, Forest Service: 73-89.

[v] Allred, W.S. and W.S. Gaud. 1994. Characteristics of ponderosa pines and abert squirrel herbivory. Southwest Naturalist. 39(1):89-100.

[vi] Parker, T.J. 2001. Bird communities in dwarf mistletoe infested ponderosa pine forests. Thesis. Northern Arizona University, Flagstaff, Arizona, USA.

[vii] Bennetts, R.E., G.C. White, F.G. Hawksworth, and S.E. Severs. 1996. The influence of dwarf mistletoe on bird communities in Colorado ponderosa pine forests. Ecological Applications. 6:899-909.

[viii] Parks, C., E. Bull, R.O. Tinnin, J.F. Shepherd, A.K. Blumton. 1999. Wildlife use of dwarf mistletoe brooms in Douglas-fir in northeast Oregon. West. J. Appl. For. 14:100-105.

[ix] Garnett, G.N., R.L. Mathiasen, and C.L. Chambers. 2004. A comparison of wildlife use in broomed and unbroomed ponderosa pine trees in Northern Arizona. West. J. Appl. For. 19:1-5.

[x] Hawksworth, F.G. and B.W. Geils. 1990. How long do mistletoe-infected ponderosa pines live? West. J. Appl. For. 5(2): 47-48.

[xi] Gill, L.S. and F.G. Hawksworth. 1954. Dwarf mistletoe control in southwestern ponderosa pine forests under management. Jour. Forestry 52: 347-353.

[xii] Hawksworth, F.G. 1961. Dwarf mistletoe of ponderosa pine in the Southwest. Tech. Bull. 1246. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station. 13p.

[xiii] Alexander, M.E. and F.G. Hawksworth. 1976. Fire and dwarf mistletoes in North American coniferous forests. Jour. Forestry. 74 (7): 446-449.

[xiv] Conklin, D.A. and W.A. Armstrong. 2001. Effects of three prescribed fires on dwarf mistletoe infection in southwestern ponderosa pine. USDA Forest Service, Southwestern Region, Forestry and Forest Health. R3-01-02. 17 p.